IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	10/692,174	Conf. No.:	8347
Applicant	:	Eldridge et al.		
Filed	:	October 23, 2003		
TC/A.U.	:	2839		
Examiner	:	Abrams, Neil		
Docket No.	:	P47C2-US		

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DECLARATION UNDER 37 CFR § 1.132 OF RODNEY MARTENS

I, Dr. Rodney Martens, declare as follows:

1. I hold a PhD in Mechanical Engineering from the University of Maryland, College Park.

2. I am currently Director, Product Quality and Reliability at FormFactor, Inc., the assignee of the above-identified patent application. I have held my current position at FormFactor since April 2008. Prior to my current position, I held the following positions at FormFactor: Technical Director, Research and Development; Senior Member, Technical Staff Research and Development; and Senior Principal Engineer, Development. I have worked for FormFactor since 2000.

3. FormFactor makes, among other things, probe cards for testing semiconductor dies. A probe card has electrically conductive spring-like probes that contact bond pads of the dies to make reliable and repeatable electrical connections with the bond pads. Since 2001, I have been actively involved in developing and testing probes for FormFactor's probe cards. A number of characteristics of the probes can be important. For example, hardness is a desirable characteristic of the contact tip of a probe. (The contact tip is the portion of a probe that contacts a bond pad of a die.) During the typical life of a probe card, the probes can be brought into contact hundreds of thousands of times with bond pads of dies. The harder the material of the contact tips, the less

the contact tips wear down, and the longer the contact tips last. Because the probes establish electrical connections with the bond pads, it is of course important that the probes, including the contact tips, have and retain during the life of the probe card a low electrical contact resistance with the material of the bond pads.

4. FormFactor's first probe card products used probes made primarily of nickel alloys. While developing the first probe cards in about 1996, FormFactor scientists and engineers began a search for a material from which to make contact tips for the probes. A primary purpose was to find a material for contact tips that would resist wear and extend the useful life of the probes. A material sufficiently hard to withstand hundreds of thousands of contacts with bond pads of dies without exhibiting appreciable wear and that reliably and repeatedly forms and maintains over the hundreds of thousands of contacts low electrical contact resistance connections with the bond pads was desired.

5. The performance of a material over hundreds of thousands of contacts with bond pads of semiconductor dies can be unpredictable. This is particularly true due to the fact that electrical signals are passed between the bond pads and the probes during the contact. Extensive experimentation was required before FormFactor scientists and engineers discovered that palladium-cobalt exhibited both sufficient hardness, and thus desirable wear characteristics, and low electrical contact resistance over hundreds of thousands of contacts with bond pads of semiconductor dies.

6. Initially, the FormFactor scientists and engineers experimented with nickel-cobalt as a material for contact tips of probes. They were using nickel-cobalt as a material for the bodies of the probes due to nickel-cobalt's structural properties as a spring. The scientists and engineers assumed nickel-cobalt would also work well as a contact material. They discovered, however, that material from the bond pads contacted by the probes adhered to the contact tips of the probes. The material from the bond pads quickly formed an electrically insulating layer on the contact tips, which increased the electrical contact resistance between the probes and the bond pads to unacceptable levels.

7. In another project, Formfactor scientists and engineers were developing probe-like contact structures for a final package application where the structures were to be permanently attached to bond pads of semiconductor dies and would need to perform less than ten test cycles

(e.g., the contact structures would need to make repeated contact with another electronic device for purposes of testing the final package less than ten times). For this application, FormFactor scientists and engineers experimented with gold-cobalt as a contact tip material. (Gold-cobalt is sometimes known as "hard gold" and is used in the industry as a contact metal for some connectors and sockets.) The scientist and engineers discovered, however, that the high temperatures used in the process of attaching the probe-like contact structures permanently to the bond pads of the semiconductor dies, cobalt had a tendency to migrate to the surface of the contact tip where the cobalt formed an oxide layer, which is not electrically conductive. The cobalt oxide layer increased the electrical contact resistance of the probe-like contact structures to unacceptable levels. FormFactor scientists and engineers did not thereafter continue to experiment with cobalt alloys as a contact material for the probe-like contact structures to be attached to bond pads of semiconductor dies. Rather, they then experimented with nickel-gold as a contact material. (It is noted that nickel-gold is too soft to be used in probes of a probe card because of the many thousands of repeated contacts such probes must make.)

9. The FormFactor scientists and engineers did not initially try palladium as a contact tip material because palladium was believed to be too soft to meet the wear requirements they were attempting to achieve. In addition, palladium can have a tendency to form electrically resistive frictional polymers when repeatedly rubbed against another structure, such as bond pads of a semiconductor die. For these reasons, the FormFactor scientists and engineers did not expect palladium to be an acceptable material for a contact tip for probes of a probe card. Nor did they expect cobalt to be a useful alloy material because of the tendency of cobalt to result in high contact resistance as discussed above.

10. Nevertheless, after other materials failed to produce acceptable results as discussed above, the scientists and engineers purchased and began experimenting with palladium-cobalt. Contrary to all expectations and after repeated attempts, the scientists and engineers discovered that palladium-cobalt met the hardness (and thus wear), low material transfer, and low electrical contact resistance characteristics required of a contact tip for a probe on a probe card used to test semiconductor dies.

11. In my opinion, the discovery by FormFactor scientists and engineers of the use of palladium-cobalt as a contact tip material for probes contacting bond pads of semiconductor dies to establish electrical connections for the passage of electrical signals between the probes and the

bond pads was unexpected. I base this opinion at least in part on the facts, set forth above, that FormFactor scientists and engineers initially expected other alloys to meet the required characteristics of a contact tip. Only after discovering that those other alloys did not produce the desired results did FormFactor scientists and engineers experiment with and discover that palladium-cobalt meets the required characteristics. I also base this opinion on the facts, set forth above, that palladium was known to form highly resistive frictional polymers when repeatedly rubbed against a structure like bond pads of semiconductor dies, and cobalt alloyed with other metals had been found to result in an unacceptably high contact resistance. Thus, there was not a reason to expect that alloying cobalt and palladium would produce a useful contact tip material for repeatedly contacting bond pads of semiconductor dies.

12. All statements herein made of my own knowledge are true and all statements made on information and belief are believed to be true. I acknowledge that willful false statements and the like are punishable by fine or imprisonment, or both (18 USC § 1001) and may jeopardize the validity of the above-identified application or any patent issuing thereon.

Respectfully submitted,

Date: June 27, 2008

Dr. Rodney Martens
FormFactor, Inc.